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A NEW GENUS OF SEA STARS (PLAZASTER) FROM JAPAN, WITH A NOTE ON THE GENUS PARASTERINA

By Walter K. Fisher

Dr. Tohru Uchida (1928) described a new sea star from Mutsu Bay, Honshu, as *Labidiaster borealis*, which appeared to refute the belief that the highly specialized *Labidiaster* is confined to Antarctic and sub-Antarctic regions. Of this genus, described by Lütken (1871, p. 289), there are two species: *L. radiosus* Lütken (synonym *L. crassus* Koehler), distributed over the Falkland Plateau and off the southern end of South America, 0–183 m.; and *L. annulatus* Sladen (1889, p. 595, pl. 108, fig. 1), an Antarctic species found at Kerguelen and Heard Islands, Antarctic Archipelago, South Orkneys, South Sandwich Islands, and South Georgia, 93–44 m.

Through the kindness of Dr. R. Hayashi, Department of Zoology, Hokkaido Imperial University, Sapporo, Japan, I have received two dried specimens of *Labidiaster borealis* Uchida from Hokkaido. One of these is larger than any recorded by Dr. Uchida, R being about 180 mm. and r 30 mm. The specimen had 35 rays of which 10 remain.

This species is not a *Labidiaster*, nor does it appear to be closely enough allied to be included in the Labidiasterinae. The various polybrachiate genera of Asteriidae are not very closely related, for the development of numerous rays seems to have arisen independently in all sorts of places. We have such divergent genera, for instance, as *Heliaster* (usually accorded family rank), *Pycnopodia*, *Coronaster*, *Rathbunaster*, *Labidiaster*, and *Saliasterias*. I have recently described a rather anomalous sub-Antarctic genus, *Psalidaster*, distantly allied to *Notasterias;* and the condition in a more restrained form exists in

genera having predominantly 5- and 6-rayed species such as *Diplasterias*, *Lysasterias*, and *Cryptasterias*.

The new genus, which may be called *Plazaster*, has crossed pedicellariae entirely different from those of *Labidiaster*, best understood by a comparison of figures. The pedicellariae of *Labidiaster annulatus* may reach enormous size. Figure 2, plate 67, if enlarged as much as figure 1, plate 66, would occupy the entire plate. They occur thickly on transverse cushions of tissue, as illustrated by Sladen (1889, pl. 108); and while those of *radiosus* are somewhat smaller they are still very large and of the same type as in *annulatus*. The shank teeth are relatively large and occur in a single series. Those of *Plazaster* are small and in several series. In *Labidiaster* much smaller pedicellariae (pl. 67, fig. 4) of several sizes occur on the thick spine sheaths, including the outer of the two adambulacral spines. In *Plazaster* there are no adambulacral spine pedicellariae, and none of the spinelets has a fleshy sheath, but a thin one. The absence of pedicellariae attached to one or more adambulacral spines is important in connection with their presence in *Labidiaster*. Adambulacral spine pedicellariae are found only in the following genera: *Asterias*, *Evasterias*, *Leptasterias*, *Stenasterias*, *Perissasterias*, *Labidiaster*, and sometimes in *Urasterias* as a variation. The majority of genera of Asteriidae have no adambulacral spine pedicellariae, although pedunculate straight pedicellariae, attached to adambulacral plates, are of common occurrence.

The skeleton of *Plazaster* is different from that of *Labidiaster*. The very numerous small plates form an extensive irregular net to the tip of ray, without a differentiated carinal and superomarginal system, and the inferomarginal plates alternate with an interpolated secondary ossicle. In *Labidiaster* the skeleton of the outer half or two-thirds of ray undergoes reduction to widely spaced transverse arches, which in old specimens degenerate to the rudiments of the marginals and a few tiny abactinals. The thick ruffs of giant pedicellariae overlie these disappearing or vanished skeletal arches. The rays of *Labidiaster* like those of *Pycnopodia* are very flexible. Both animals can catch active prey.

It is difficult to name the genus to which *Plazaster* is most closely related and therefore to place it satisfactorily in the system. It differs from the Labidiasterinae in the type of reticulate skeleton, in the inferior status of the marginal plates, and in lacking prominent stoles of pedicellariae on the principal spines. At the same time the ambulacral plates are rather too primitive and uncrowded for the Asteriinae. The genus is in fact very isolated. The weak but complete skeleton, in conjunction with the primitive ambulacrals, suggests the Pedicellasterinae. All known species in this subfamily have five or six rays and lack an adoral carina, the first pair of adam-

bulacrals behind mouth plates being at least partly separated. But no species with numerous crowded rays can very well be constructed on the plan of the asteriid actinostomial skeleton and at the same time dispense with a strong adoral carina such as *Plazaster* possesses.

Plazaster has a stout pillar of plates extending from the odontophore to the dorsal wall, and involved in the partly membranous interbrachial septum. Such a buttress might seem to be an adaptation required by the broader disk. *Psalidaster* and *Labidiaster* have such a buttress, although *Rathbunaster* with a smaller disk and deciduous rays has not. The ordinary small Pedicellasterinae do not need a buttress to support the disk. The dorsoventral pillar is characteristic of the Coscinasteriinae also, without relation to size of disk; but in this group the ambulacrals become increasingly crowded and the carinal and marginal systems of plates are strongly developed, with voluminous stoles of pedicellariae on the spines. Nor is *Plazaster* close to the Pycnopodiinae (*Lysastrosoma, Pycnopodia*), which have very compressed ambulacrals like the Asteriinae.

Possibly the best disposition of *Plazaster* is to regard it as a polybrachiate offshoot of the Pedicellasterinae, differing principally in having a long adoral carina.

PLAZASTER, new genus

Rays 22 [1] to 35; skeleton reticulate with very numerous irregular meshes extending to end of rays; plates small, usually with one small acicular spinelet; superomarginals not differentiated or joined in longiseries; inferomarginals small, monacanthid or diplacanthid, alternating with a secondary spineless plate and joined directly to adambulacrals; no rudimentary actinals; adambulacrals diplacanthid or triplacanthid, without spine pedicellariae; integument thin and crossed pedicellariae attached in circles at base of spinlets; crossed pedicellariae with jaw expanded distally bearing two enlarged lateral teeth; shank teeth numerous, small, in several longiseries; gonads two to a ray, opening dorsolaterally at about diameter of disk distant from base; a membranous interbrachial septum with strong dorsoventral pillar of plates from odontophore.

Type, *Labidiaster borealis* Uchida.

PLAZASTER BOREALIS (Uchida)

PLATES 66, 68, 69

Labidiaster borealis UCHIDA, 1938, p. 800, fig. 9, pl. 33, figs 1, 2 (young).

Description.—R 180 mm., r 30 mm., R=6r, 35 rays. R 60 mm., r 12 mm., R=5r, 33 rays. The skeleton is an irregular net of very numerous small plates, usually 3-lobed at the nodes, elsewhere irregu-

[1] Specimen with R 30 mm., r 5.5 mm. (Uchida).

larly oblong. On the disk the skeletal intervals are very small—about the size of the primary lobed plates—but on the rays they are more open, especially above the inferomarginals where they are very large. The inferomarginals, which are applied to the outer end of the adambulacral plates, are 3-lobed and not directly imbricated: There is a secondary elliptical ossicle between any two. The inferomarginals proximally often have two acicular spines the length of three adambulacral plates but usually there is one. Applied to upper lobe of inferomarginals is an oblong plate, not different from others above it, which probably represents the superomarginal. But there is no clearly differentiated series of superomarginals or of carinal plates. The latter can not be distinguished from among the numerous abactinal plates.

Most of the abactinal plates carry a slender, sharp spinelet 1 to 1.5 mm. long, surrounded at the base by four or five crossed pedicellariae, 0.35 to 0.45 mm. long, having one prominent tooth on each side of the tip of jaw and very numerous shank teeth in several longiseries. In the aggregate these pedicellariae are very numerous, but thin out on the sides of ray, proximally. The proximal inferomarginal spinelets usually carry basally only one or two small lanceolate straight pedicellariae but beyond middle of ray are equipped with a circlet of crossed pedicellariae. The straight pedicellariae are also scattered over the surface of the body, usually on papular areas, and are one-half to three-fourths the length of spinelets. Papulae numerous but difficult to determine accurately because the specimens have been dried. On the disk each small mesh has one papula.

The adambulacral plates are short, rather broad, and characteristically curved. They carry three slender spines, obviously longer than the inferomarginals and without any attached pedicellariae. However, on the furrow face of the plate, near base of the furrow spine, one or more pedunculate straight pedicellariae of different sizes usually occur. The adambulacral and oral spines are the longest of the body and form a dense cheval-de-frise on either furrow margin. The small mouth plates each carry one prominent suboral and two often flattened actinostomial spines, as well as a variable number of pedunculate lanceolate straight pedicellariae. The adoral carina is composed of the first seven pairs of adambulacral plates; the first five may carry three, two, or occasionally only one spine.

In *Labidiaster* the mouth plates of good-sized specimens become so crowded that the inner or actinostomial angle meets and fuses with that of the opposite side of furrow in such a manner that the radial nerve has to pass through a hole arched over by these fused plates. In *Plazaster* there is no fusion of the mouth plates. For one thing the actinostomial border of the plates is not so expanded as in *Labidiaster*.

The madreporite, 4.5 mm. in diameter, is situated at mid-r.

There are two gonads in each ray. Each consists of a bunch of branched slender lobes attached to the dorsolateral body wall 35 mm. from the base of ray.

A short pillar of plates unites the odontophore with the abactinal skeleton as an obvious support. From and including this pillar a membranous septum passes interradially to the margin of disk, where it again becomes fortified by a short septum of plates proceeding inward from the margin. These plates are continuous with the skeleton of side of ray, the lowermost elements of the septum being marginal plates.

The ambulacral plates are not particularly thin or compressed, and the ambulacral pores form a straight, not zigzag, series. The tube-feet, arranged in two series, are apparently fairly large and crowded in the narrow ambulacral grove. The ampullae are simple, not bilobed.

Type locality.—Mutsu Bay, northern Honshu, Japan.

Specimen described, Hokkaido, Japan, U.S.N.M. No. E. 5952.

Distribution.—Northern Honshu and Hokkaido, Japan.

NOTE ON THE GENUS PARASTERINA

In the literature on sea stars there have been two quasidistinct genera bearing the name *Patiria.* They started as follows:

1. *Patiria* Gray, 1840, type *P. coccinea* Gray, monotypic. In 1847 Gray enlarged the genus to include *granifera* Gray, *ocellifera* Gray, *obtusa* Gray, and *crassa* Gray.

2. *Patiria* Perrier, 1875. "En adoptant ici le genre *Patiria* de Gray nous changeons notablement les limites et la charactéristique de ce genre." Perrier discarded Gray's type, *coccinea,* and included only *ocellifera* and *crassa,* the last obviously different from *coccinea* and *granifera.* Sladen (1889, p. 384) adopted Perrier's genus, omitting *coccinea* from the list of included species, to which he added a new one, *bellula* from Cape of Good Hope.

Gray's *Patiria* became submerged in the more extensive *Asterina* of Nardo, 1834.

Perrier's *Patiria* was stated to differ from *Asterina* in having the dorsal ossicles convex, nearly circular and touching one another, not imbricated as is ordinarily the case in *Asterina.* Sladen (1889, p. 376) differentiated the two groups as follows:

Abactinal plates not imbricated; covered with spines: *Patiria.*

Abactinal plates imbricated throughout the abactinal area, or only in definite regions: *Asterina, Nepanthia, Disasterina.*

This seemed to be a sound distinction; and, as *Patiria* Perrier was obviously invalidated by *Patiria* Gray, I renamed Perrier's group *Parasterina,* type *Patiria crassa* Gray (Fisher, 1908, p. 90).

In 1913 Verrill subdivided *Asterina* and resuscitated *Patiria* Gray for the common Pacific coast *Asterina miniata* (Brandt). Mortensen (1933, p. 257) has ascertained that Gray's *Patiria coccinea* is actually this *P. miniata* (Brandt) and has published a photograph of one of the types. Even if the type should prove to be a specimen of the Japanese *P. pectinifera* it will make no difference, as the two species are closely related.

I recently examined specimens of *Patiria granifera* Gray and *P. bellula* Sladen from the Cape region, South Africa (pl. 70, fig. 1). Both belong to Gray's *Patiria* (not to *Parasterina*) and are probably two formae of the same species. *Callopatiria* Verrill, 1913, type *Patiria bellula* Sladen, is a synonym of *Patiria* Gray.

Now I have discovered that the alleged distinctive character of *Parasterina* does not exist in the type species! Through the kindness of Dr. H. L. Clark I have been able to study a specimen of *Patiria crassa* from near Fremantle, Western Australia. This specimen has R 45 mm., r 10 mm., br 11–12 mm., and the abactinal aspect resembles superficially that of *Nardoa variolata*, as the convex primary plates are spaced and the spinelets extremely fine, close-set, and visible only under strong magnification. The species is quite unlike a true *Patiria* but resembles *Nepanthia*. In fact the actinal surface does not differ from that of *Nepanthia* (e. g., *N. belcheri*) in any important particular. The actinal plates are covered with coordinated groups of very numerous spinelets. There are 15–18 similar subambulacral spinelets, and 8 or 9 furrow spinelets. The inner longiseries of actinal plates extends to three or four inferomarginals short of the end of ray; the next two series nearly as far; the fourth series about three-fifths length of ray measured on side; while a fifth and a sixth series constitute a small additional chevron in the interbrachial angle.

The two series of marginal plates are quite regular, and correspond, plate to plate; they are obviously larger than the adjacent abactinals and actinals, which are small.

There are two differentiated areas on the abactinal surface: (1) A lateral triangular area reaching at interradius, one-half r toward center of disk and distally nearly half length of ray; from this point it extends usually as a double series of plates nearly to tip of ray. The plates of this area, in regular longiseries, strongly imbricate, and the upper margin is excavated to accommodate a papula (fig. 21). Around this papular opening are two to four small superficial plates. Nearly all the plates carry a spiniform pedicellaria. (2) The other area, that of the convex primary plates, comprises the central part of disk and rays. It broadens distally to include most of the sides of ray also (pl. 70, fig. 2). The roundish and irregular, convex, almost tuber-

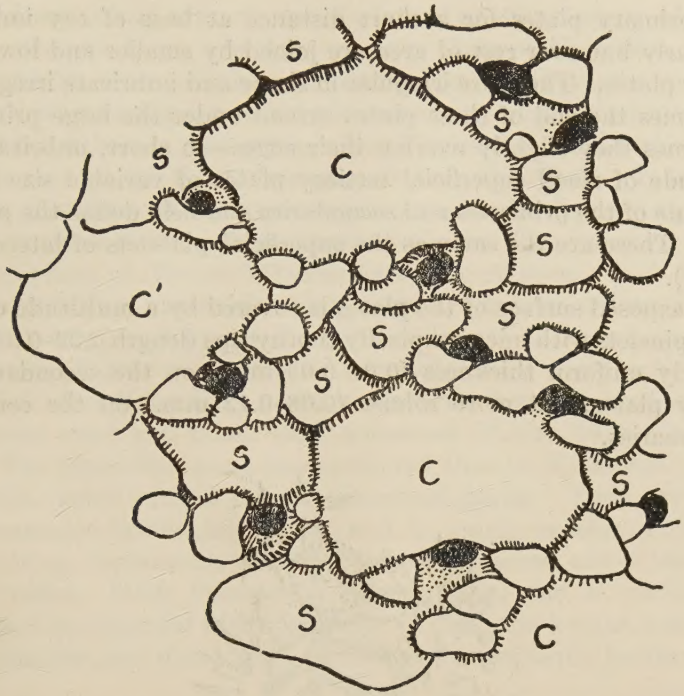

FIGURE 20.—*Nepanthia crassa* (Gray): Abactinal plates near base of ray, × 20. *C*, carinals; *S*, secondary plates; tertiaries not lettered. Black areas are papular pores. Hatching indicates border of plate overlapped by adjacent plate. When hatching is on both sides of boundary line there is no overlapping.

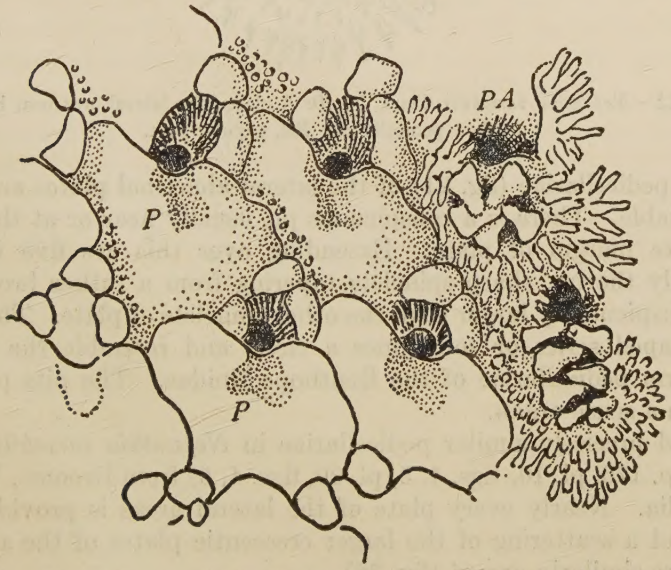

FIGURE 21.—*Nepanthia crassa*, × 20: Six lateral plates of the third and fourth series above superomarginals near base of ray, to show pedicellariae (right). Four plates are denuded to show their shape and the pedicellaria pits (*P*, *P*). *PA*, papular pore.

cular primary plates for a short distance at base of ray imbricate irregularly but over rest of area are joined by smaller and lower secondary plates. These are irregular in shape and imbricate irregularly. Sometimes the end of these plates extend under the large primaries, sometimes they slightly overlap their edges—in short, imbricate. A multitude of small superficial tertiary plates of variable size fortify the joints of the primaries and secondaries and help define the papular pores. These are the same as the superficial platelets of lateral area (fig. 20).

The exposed surface of the plates is covered by a multitude of very small spinelets with microscopically thorny tips (length 0.22–0.28 mm.) of nearly uniform thickness (0.04–0.05 mm.) on the secondary and tertiary plates, but more robust (0.08–0.12 mm.) on the center of the primaries.

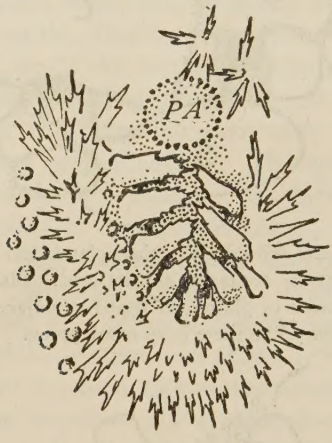

FIGURE 22.—*Nepanthia variabilis* Clark, × 40: A plate from lateral area near base of ray to show pedicellaria. *PA*, papular pore.

The pedicellariae (fig. 21) of the lateral abactinal plates are rather remarkable. There is a conspicuous pit usually near or at the upper excavate margin of plate. Extending over this are five to eight minutely thorny, sharp spinelets tapering from a rather broad base and conspicuously larger than the other spinelets of plate. They form a U-shaped series or sometimes a circle and resemble the circular spiniform pedicellariae of the Benthopectinidae. The pits probably contain a sense organ.

I find precisely similar pedicellariae in *Nepanthia variabilis* Clark (1938, p. 176, pl. 10, figs. 4, 5, pl. 20, figs. 4, 5) from Broome, Western Australia. Nearly every plate of the lateral areas is provided with one, and a scattering of the larger crescentic plates of the abactinal area, are similarly armed (fig. 22).

The adambulacral, actinal, and the lateral abactinal plates of *Parasterina crassa* are in no way different from those of *Nepanthia*. This leaves only the enlarged plates of the median abactinal area with the numerous intervening secondary plates and superficial tertiary plates upon which to base a new genus. But *Parasterina occidentalis* Clark (1938, p. 180, pl. 21, fig. 5) has no secondary abactinals. It is questionable, therefore, whether we can place too much reliance for generic characters upon these median abactinal plates. The behavior of the abactinal plates of *Nardoa* furnishes reason for caution. In *N. pauciforis* the plates are numerous, small, and most nearly uniform in size. Somewhat larger and progressively more diverse as to size are those of *N. mollis*, *N. tuberculata*, and *N. novaecaledoniae*, while in *N. tumulosa* and *N. frianti* the large primary plates are hemispherical and the secondaries small and much more numerous (Fisher, 1919, pls. 108–110). The possibility must be considered that in *Nepanthia* species exist with overdeveloped primary abactinal plates. They are not a rare occurrence in the Asteroidea, and in certain species of the Asteriidae (e. g. *Leptasterias polaris*, *Pisaster ochraceus*) are of less than specific value. Both *Parasterina crassa* (Gray) and *P. occidentalis* Clark must be regarded with suspicion. I think the former is an aberrant *Nepanthia*, and that *Parasterina* should consequently be discarded.

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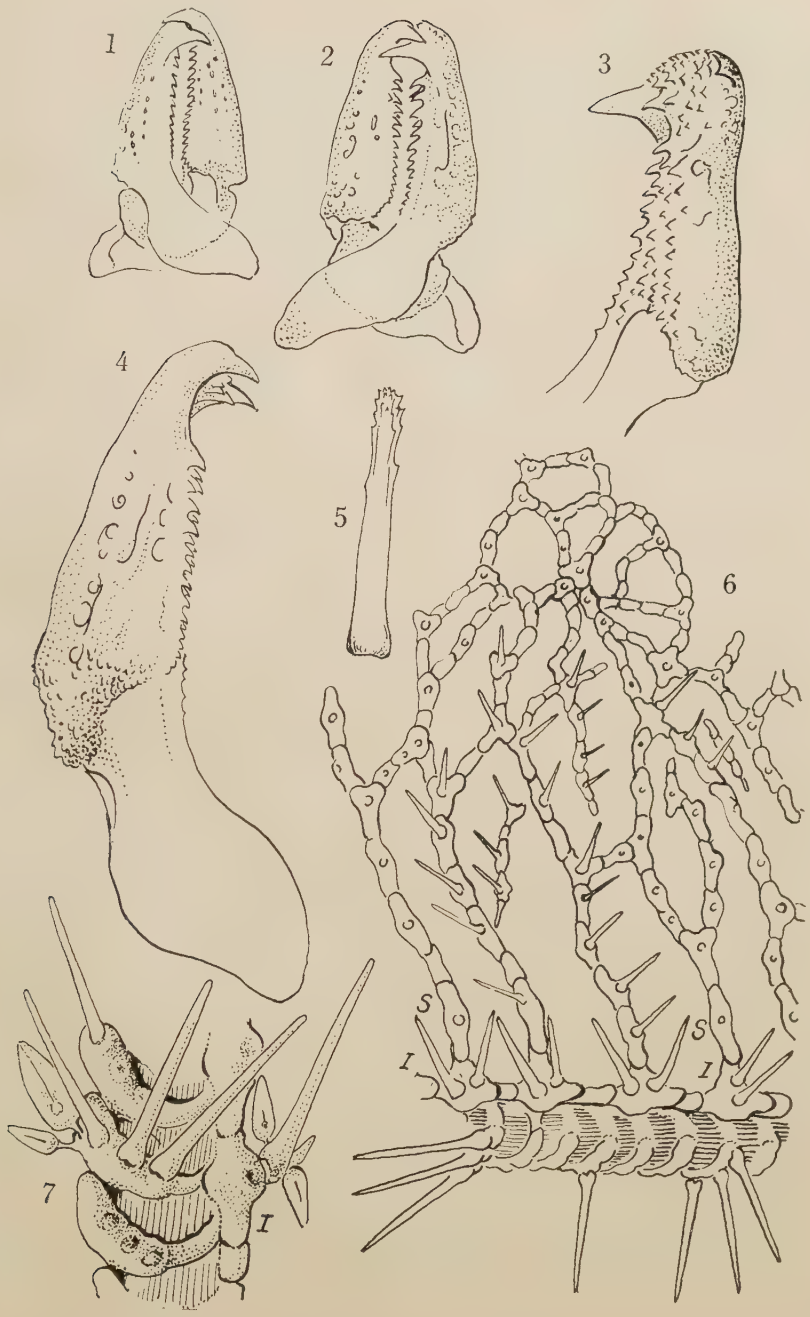


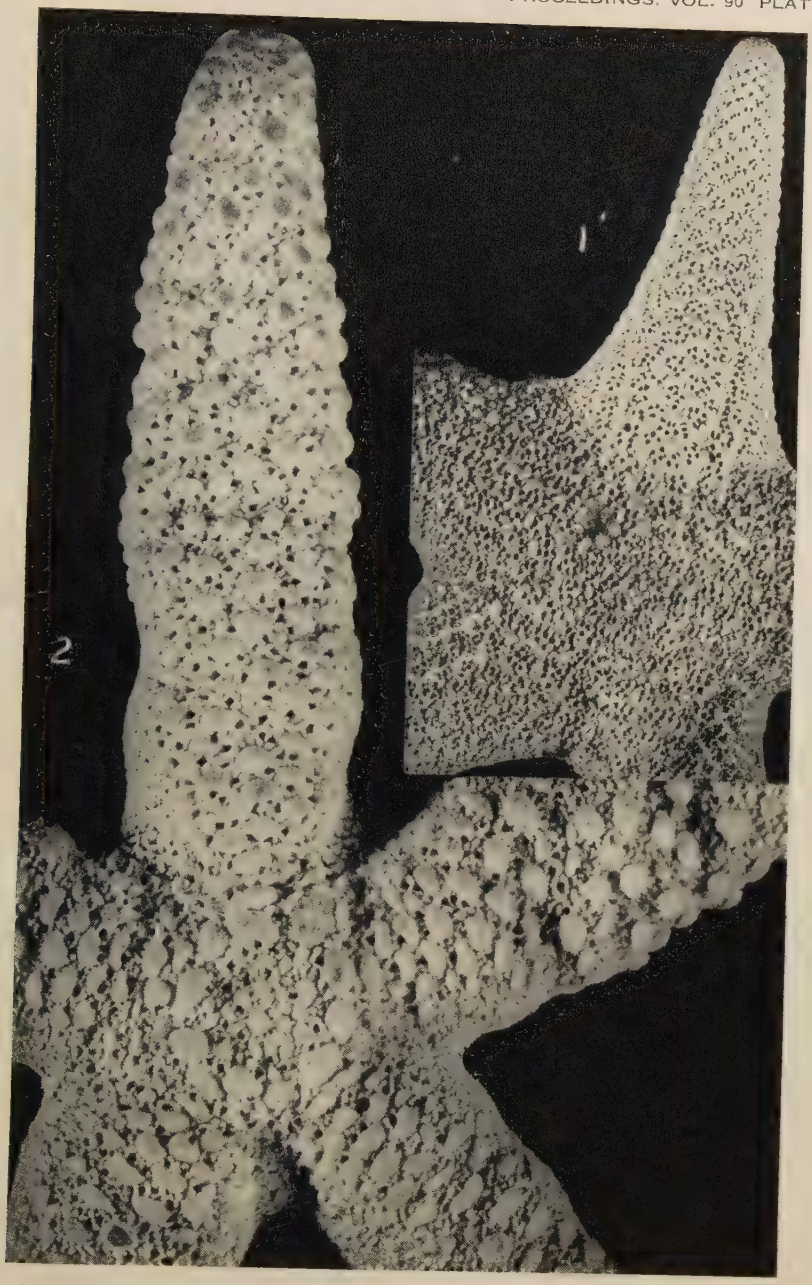
Plazaster borealis (Uchida): 1, Pedicellaria from abactinal spine, 0.36 mm. long, × 100; 2, same, 0.45 mm., × 100; 3, interior of jaw of a pedicellaria showing the numerous teeth in several series, × 200; 4, a single jaw, × 200; 5, abactinal spinelet, 1.4 mm. long, × 25; 6, skeleton of ray, near base which is to the right, from the adambulacrals to midradial line, × 5 (*I*, inferomarginals; *S*, probable superomarginals); 7, three adambulacral plates from near middle of ray, with adjacent inferomarginal (*I*). × 10.

1–4, *Labidiaster annulatus* Sladen: 1, Adambulacral and marginal plates, proximal third of ray, × 5 (*A*, outer adambulacral spine carrying pedicellariae shown in fig. 4; *I*, inferomarginal spine; *P*, giant pedicellariae; *S*, superomarginal spine); 2, 3, one of the numerous giant pedicellariae from the annular pads of tissue, two views, 1.7 mm. long, × 50; 4, a pedicellaria from outer of the two adambulacral spines, 0.27 mm. long, × 100.

5, *L. radiosus* Lütken: Plan of skeleton of ray, the base to left, × 5 (*A*, outer end of ambulacral plates, dotted; *AD*, adambulacral plates; *C*, carinals; *I*, inferomarginals; *S*, superomarginals).

Plazaster borealis (Uchida): Abactinal and lateral surfaces of five rays and about half of disk. Natural size.

Plazaster borealis (Uchida); Actinal surface of three rays and part of disk. A detached ray to show skeleton, slightly enlarged.



1, *Patiria granifera* Gray, from Simonstown, False Bay, South Africa. The abactinal skeleton of one ray has been cleaned to demonstrate the secondary plates characteristic of *Patiria*.
2, *Nepanthia crassa* (Gray), × 2¾. The spinelets have been removed from the plates of one ray to show secondary and tertiary plates.